UNMANNED/MINIMALLY MANNED SYSTEMS AND ENABLING TECHNOLOGIES

Matthew Ganz, Ph.D.
Director
DARPA/STO

1

AGENDA

Robotics	- E. Krotkov
Unmanned Tactical Vehicle	- L. Birckelbaw
Tier 2+/Tier II - HAE UAVs	- C. Heber
Low-Cost Cruise Missile Defense	- J. Carlini
Breakthrough Technologies Materials and Processing	- S. Wax

WHY UNMANNED/MINIMALLY MANNED SYSTEMS

Avoid Putting People In Physical Danger

Accomplish Superhuman Tasks

Affordability

3

Why Unmanned/Minimally Manned Systems. There are several reasons why unmanned and minimally manned systems will grow in importance to the military. The first reason is the accomplishment of tasks that are too dangerous to put a human life at risk. Unexploded ordnance disposal is an obvious example. The second is the ability to accomplish superhuman tasks—both physical and computational. The third is affordability. There are many missions where it is not cost effective to send a person, either because the job is too trivial or because the cost of the required life-support system is not justifiable

AVOID PUTTING PEOPLE IN HARM'S WAY

UXO Clearing

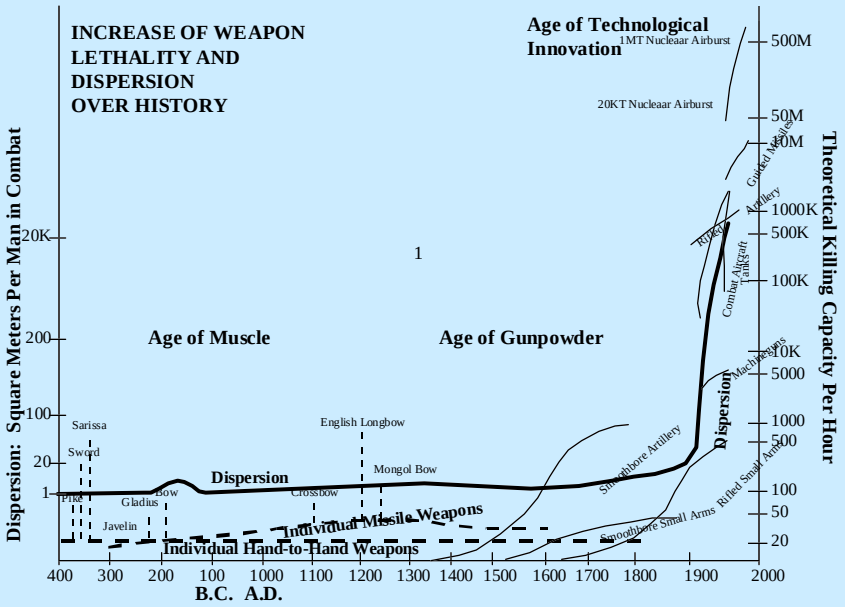
Baghdad During Desert Storm

Recon

4

Avoid Putting People in Harm's Way. There are several types of missions that are too dangerous to put a human life at risk. Unexploded ordnance disposal is an obvious example. The picture on the left shows a commercially available robot that police forces and the military use for this purpose. The center picture shows the anti-aircraft artillery over Baghdad on the first night of Operation Desert Storm. The high density of fire made the environment below about 10,000 ft. too hostile to fly manned aircraft. Therefore, we used a mix of high-altitude strike aircraft and low-flying unmanned cruise missiles to deliver the ordnance in this dangerous environment. Finally, the U.S. has several emerging reconnaissance UAV programs that allow sensor payloads to be flown much more aggressively (with respect to ground-based air defenses) than existing manned systems such as U-2 aircraft.

WEAPONS EFFECTIVENESS



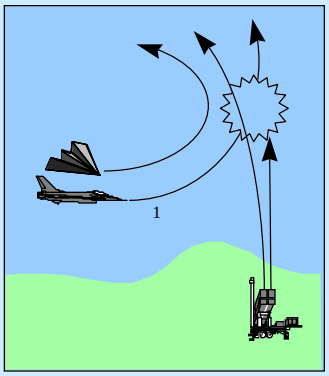
5 Acknowledgement: Col. Trevor N. Dupuy, US Army, Ret., *The Evolution of Weapons and Warfare*, © 1984

Weapons Effectiveness. This is a very interesting chart. It shows the effectiveness of weapons systems over the course of history. From the chart you can see that until about the Napoleonic Wars of the early 19th century, the effective combat radius of a warrior was a few meters or less. However, with the advent of rifled arms, automatic weapons, artillery, aircraft and weapons of mass destruction, the potential killing radius of weapons radically increased. Commensurately, there became a dramatic dispersion of troops on the battlefield. There are two important implications of these data with respect to unmanned systems. The first is that as the battlefield becomes large (i.e., theater wide), it becomes necessary to populate the battlefield with extremely small units. These units may find it difficult to defend themselves against pockets of organized resistance. Unmanned sensors and systems can eliminate the potential danger to humans in this situation. The second major implication is the importance in modern times of weapons of mass destruction. The potential for nuclear, chemical and biological weapons on the battlefield make it an extremely inhospitable environment for humans. Robotic systems, although limited in their reasoning ability, are generally impervious to the poisons that hinder or eliminate biological systems.

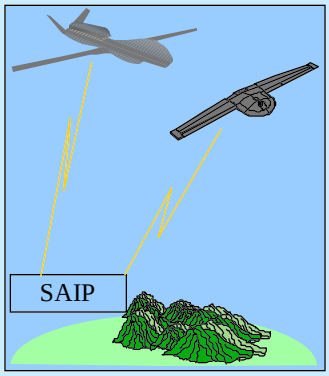
DOING SUPERHUMAN TASKS

Damaged MIR Space Station

Exceed Human Dexterity Limits



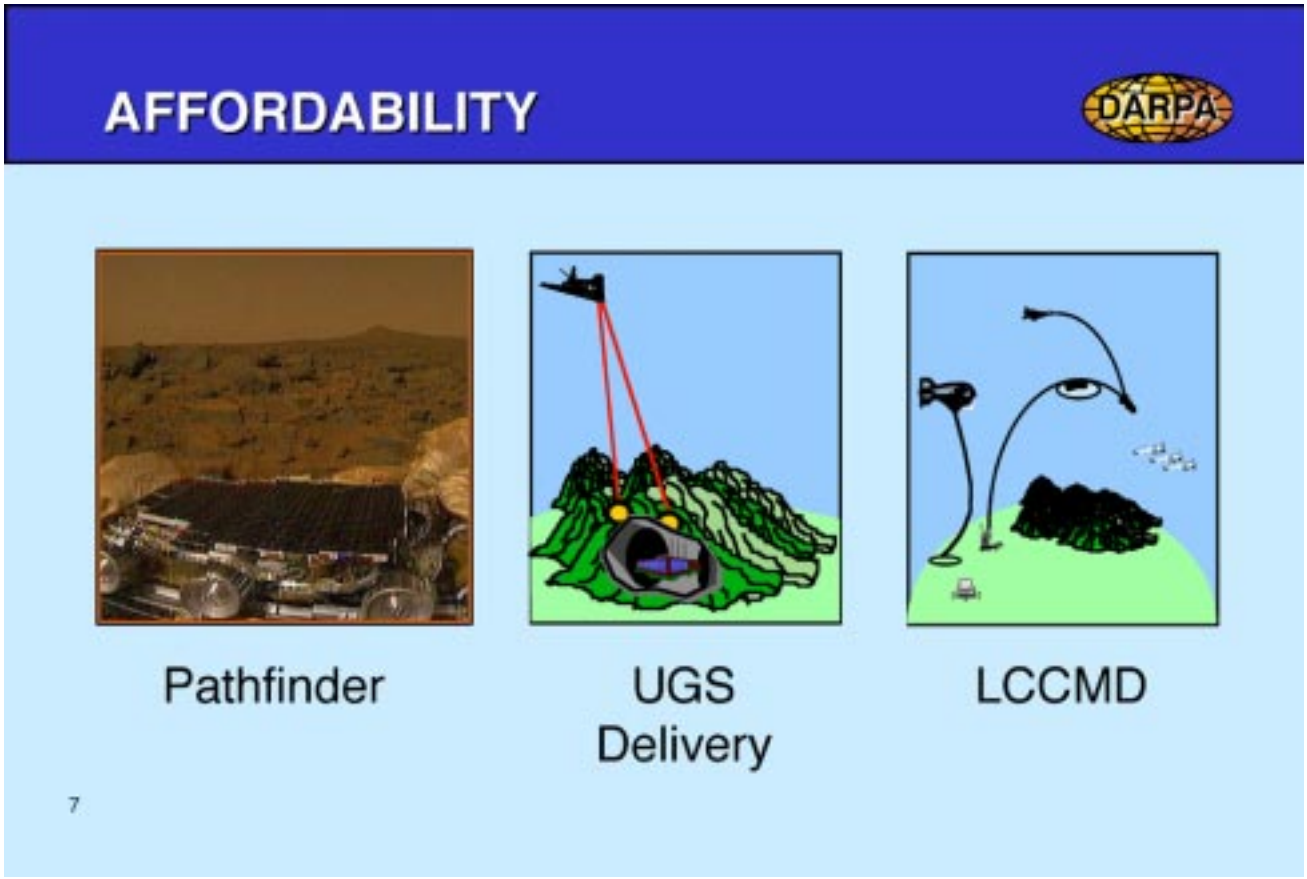
Exceed Human Physiological Limits



Exceed Human Information Processing Abilities

6

Doing Superhuman Tasks. The ability of robotic systems to do superhuman tasks is obvious. We had an example earlier this summer on the Mir Space Station of a human doing a task which had been done dozens of times by automatic systems. In the excitement of the moment, something went wrong with disastrous consequences. Again, the automatic docking of Progress supply ships and the Mir had been routine. The center drawing on this chart is a cartoon where I intended to indicate the potential of unmanned systems to exceed human physiological limits. In this case we show a notional fighter aircraft that can pull more than 9 g's (the human limit). The agility of such a fighter would make it much more survivable against enemy fighters and/or missiles. Finally, in the right-hand drawing, I indicate that the line that separates robotic systems and information technologies is somewhat blurry. Programs like DARPA's Semi-Automated Image Processing (SAIP) Program are designed to replace human operators with machines. In the case of SAIP, imagery analysts are replaced with automated target recognition software. This is an example of machines replacing humans doing tasks that are cognitive, not physical. The performance of SAIP is currently poorer than that of human operators. However, the computers have an infinite attention span and can be grown to take on a volume of work that would take hundreds or thousands of humans.



Affordability. Finally, there are several times when we would like to employ robotic systems because we simply would not choose to spend the money to have a human do the job. The Mars Pathfinder mission is an extremely good example of this. Sending a person to Mars would certainly cost several billion dollars, where the cost of the Pathfinder mission was about $250M. This is clearly a case where we chose to do the job with a robot since we simply did not have the resources for the manned mission. Similarly, unattended ground sensors represent systems whose value is too small to justify the cost of human emplacement and/or operation. Finally, you will hear later this afternoon about some ideas we have for cruise missile defense. These ideas represent the evolution of modern surface-to-air and air-to-air missiles to perform tasks in a threat environment where it would be too expensive to replicate existing air-defense architectures.

AGENDA

- Robotics
- Unmanned Tactical Vehicle
- Tier 2+/Tier 3 - HAE UAVs
- Low-Cost Cruise Missile Defense
- Breakthrough Technologies
  - Materials and Processing

8